



(12) **United States Patent**
Du

(10) **Patent No.:** **US 9,263,477 B1**
(45) **Date of Patent:** **Feb. 16, 2016**

(54) **TRI-GATE DISPLAY PANEL**

(71) Applicant: **SHENZHEN CHINA STAR OPTOELECTRONICS TECHNOLOGY CO., LTD.**, Shenzhen (CN)

(72) Inventor: **Peng Du**, Shenzhen (CN)

(73) Assignee: **SHENZHEN CHINA STAR OPTOELECTRONICS TECHNOLOGY CO., LTD.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/416,456**

(22) PCT Filed: **Dec. 15, 2014**

(86) PCT No.: **PCT/CN2014/093887**

§ 371 (c)(1),

(2) Date: **Jul. 1, 2015**

(30) **Foreign Application Priority Data**

Oct. 20, 2014 (CN) 2014 1 0559614

(51) **Int. Cl.**

H01L 27/12 (2006.01)

H01L 33/38 (2010.01)

(52) **U.S. Cl.**

CPC **H01L 27/124** (2013.01); **H01L 27/1214** (2013.01); **H01L 27/1255** (2013.01); **H01L 33/38** (2013.01)

(58) **Field of Classification Search**

CPC H01L 27/124; H01L 27/1214; H01L 27/1255; H01L 33/38

USPC 257/72, 88, 89; 349/139, 149
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,353,138 A * 10/1994 Van Winsum G02F 1/1365 349/109

5,668,613 A * 9/1997 Kim G02F 1/136213 349/38

(Continued)

FOREIGN PATENT DOCUMENTS

CN	101271658 A	9/2008
CN	101414451 A	4/2009
CN	103293809 A	9/2013
CN	103872077 A	6/2014

OTHER PUBLICATIONS

International Search Report and Written Opinion (Forms PCT/ISA210 and PCT/ISA/237) issued on Jul. 23, 2015, by the State Intellectual Property Office of China, in corresponding International Application No. PCT/CN2014/093887. (9 pages).

Primary Examiner — Matthew Landau

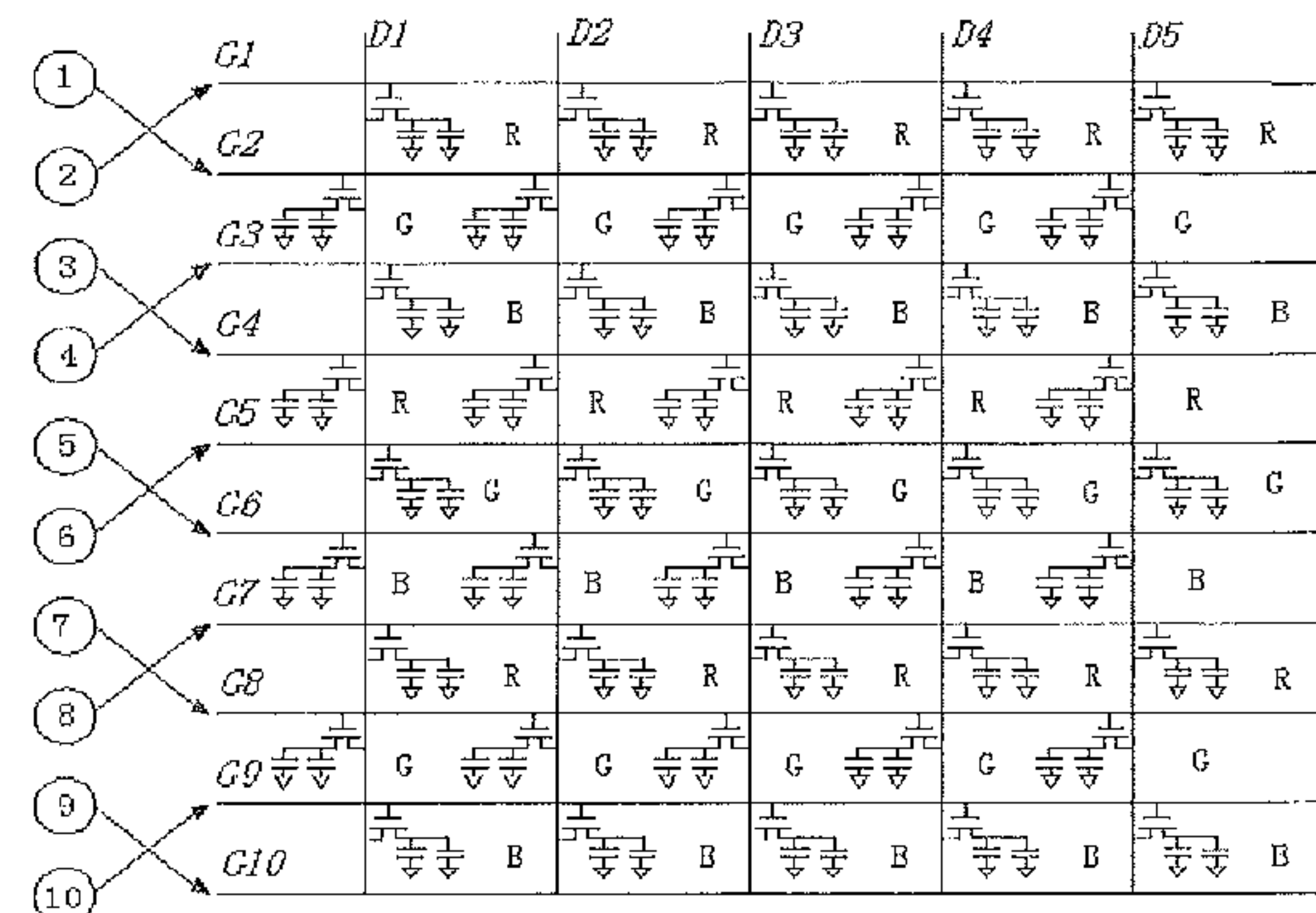
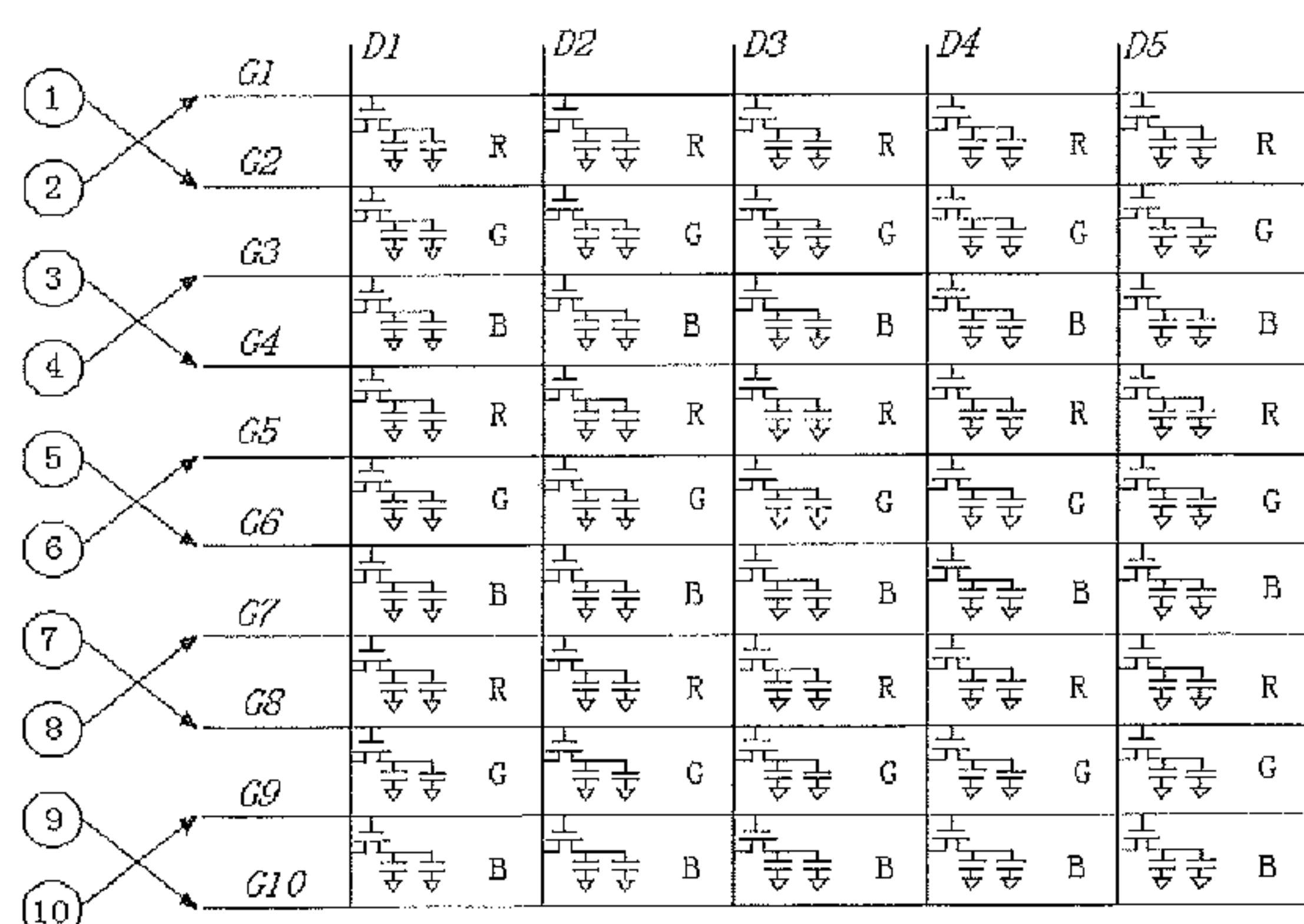
Assistant Examiner — Grant Withers

(74) *Attorney, Agent, or Firm* — Buchanan Ingersoll & Rooney PC

(57) **ABSTRACT**

A tri-gate display panel is provided, comprising: a plurality of pixel units each including three sub-pixel units for displaying different colors, wherein each sub-pixel unit is provided with a thin film transistor which has its source connected to a charge electrode of the sub-pixel unit via a capacitor of the sub-pixel unit per se; a plurality of gate lines which are successively arranged along a first direction of the display panel, so as to connect to gates of the thin film transistors of corresponding sub-pixel units; a plurality of data lines, which are successively arranged along a second direction of the display panel, so as to connect to drains of the thin film transistors of corresponding sub-pixel units; and a fanout area including a plurality of fanout lines, wherein output terminals of the plurality of fanout lines are arranged in accordance with the plurality of gate lines and are in pair-wise cross connections to the plurality of gate lines. According to the present disclosure, charging differences between different colors of sub-pixels can be reduced. Hence, color shifting of a blending picture at two sides of the panel can be avoided and display effects can be improved.

7 Claims, 5 Drawing Sheets



Page 2

References Cited

2010/0245733	A1 *	9/2010	Ono	G02F 1/13394 349/106
2010/0289792	A1 *	11/2010	Liao	G09G 3/3614 345/213
2011/0089423	A1 *	4/2011	Kwon	H01L 23/544 257/59
2011/0096258	A1 *	4/2011	Shim	G02F 1/1333 349/39
2011/0109859	A1 *	5/2011	Ito	G02F 1/134363 349/139
2011/0227816	A1 *	9/2011	Nakamura	G02F 1/133707 345/92
2012/0050657	A1 *	3/2012	Lin	G02F 1/136286 349/139
2012/0104419	A1 *	5/2012	Liao	G02F 1/133351 257/88
2012/0268703	A1 *	10/2012	Funakoshi	G02F 1/134363 349/139
2013/0002975	A1 *	1/2013	Wen	G02F 1/1309 349/54
2013/0009661	A1 *	1/2013	Chen	G02F 1/1309 324/760.02
2013/0044094	A1 *	2/2013	Li	G09G 3/3406 345/211
2013/0076808	A1 *	3/2013	Zhang	G09G 3/3677 345/694
2013/0088679	A1 *	4/2013	Lu	G09G 3/006 349/139
2013/0135281	A1 *	5/2013	Hou	G09G 3/3648 345/212
2013/0292713	A1 *	11/2013	Wu	G02F 1/136259 257/88
2014/0009448	A1 *	1/2014	Chi	H01L 27/124 345/204
2014/0009708	A1 *	1/2014	Lee	G02F 1/136286 349/43
2014/0054624	A1 *	2/2014	Chen	H01L 27/156 257/89
2014/0078032	A1 *	3/2014	Xia	G09G 3/3648 345/92
2014/0091343	A1 *	4/2014	Nakano	G02F 1/133516 257/89
2014/0103345	A1 *	4/2014	Yang	H01L 27/124 257/57
2014/0104148	A1 *	4/2014	Wang	G09G 5/00 345/92
2014/0160695	A1 *	6/2014	Jeong	H05K 3/305 361/749
2014/0353668	A1 *	12/2014	Du	H01L 27/124 257/72
2014/0354616	A1 *	12/2014	Liao	G09G 3/3696 345/212
2014/0375344	A1 *	12/2014	Wang	G09G 3/006 324/750.3
2015/0002561	A1 *	1/2015	Yao	G02F 1/136213 345/694
2015/0015821	A1 *	1/2015	Lo	G02F 1/1368 349/43
2015/0138471	A1 *	5/2015	Dong	G02F 1/13306 349/43
2015/0173232	A1 *	6/2015	Chai	H05K 7/06 361/748
2015/0187797	A1 *	7/2015	Xu	H01L 21/28008 257/347
2015/0255487	A1 *	9/2015	Yoshida	G02F 1/1345 257/43
2015/0261057	A1 *	9/2015	Harris	G02F 1/167 359/271
2015/0286084	A1 *	10/2015	Yoshida	G02F 1/1345 257/43
2015/0294611	A1 *	10/2015	Zheng	G09G 3/2003 345/694
2015/0294632	A1 *	10/2015	Chen	G02F 1/134336 345/215
2015/0295575	A1 *	10/2015	Lee	H03K 17/693 327/416

* cited by examiner

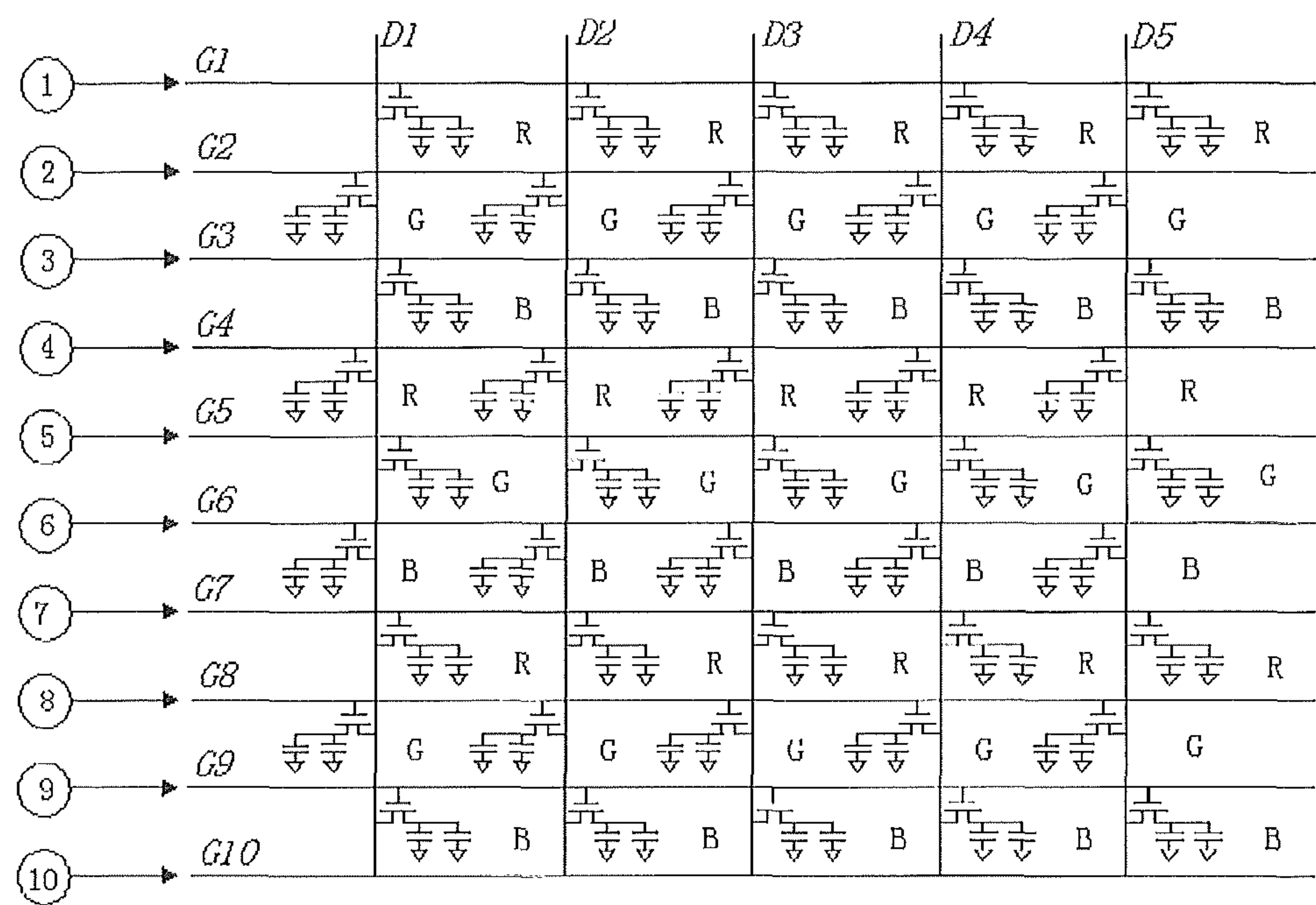


Fig. 1

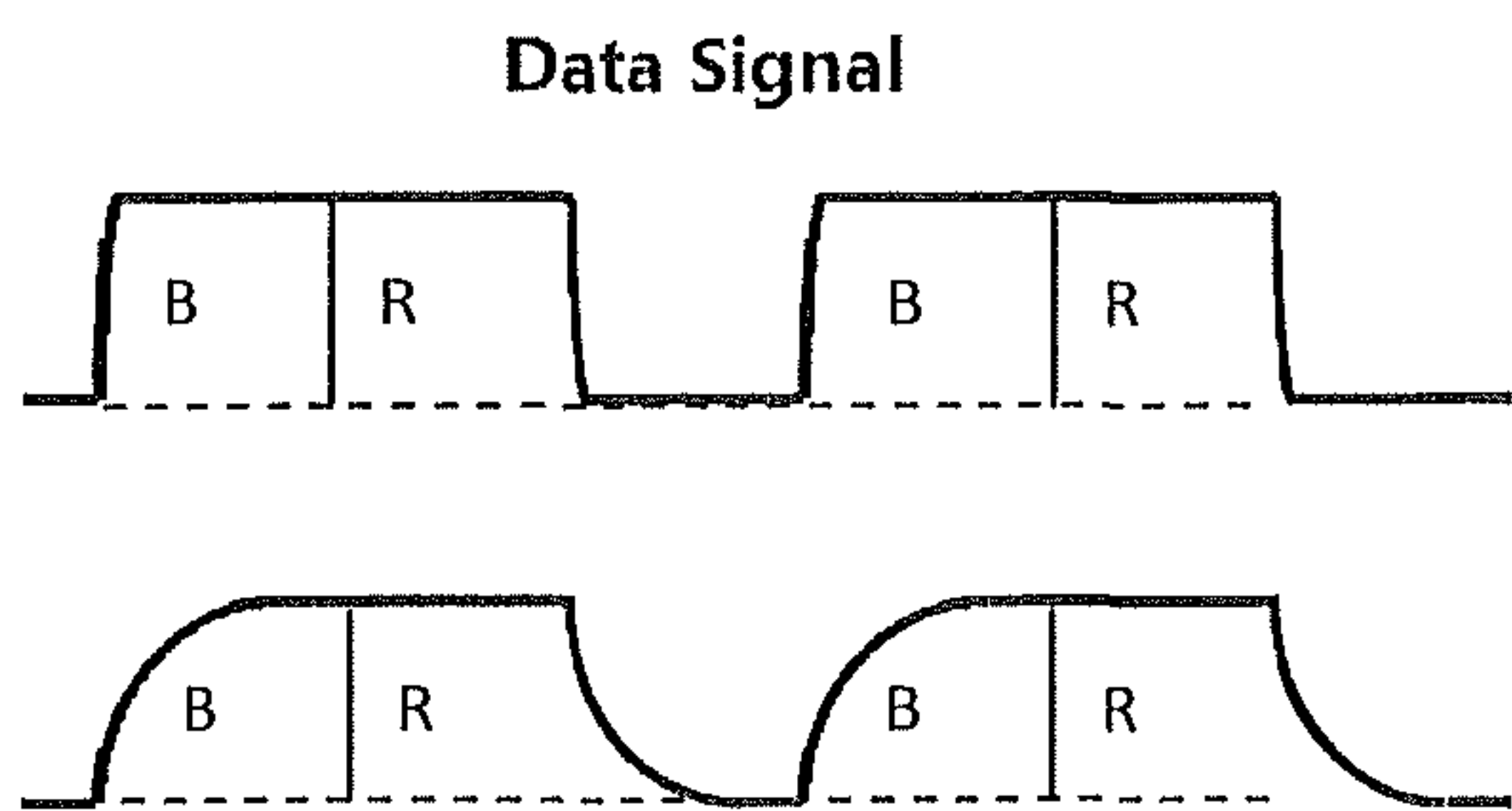


Fig. 2

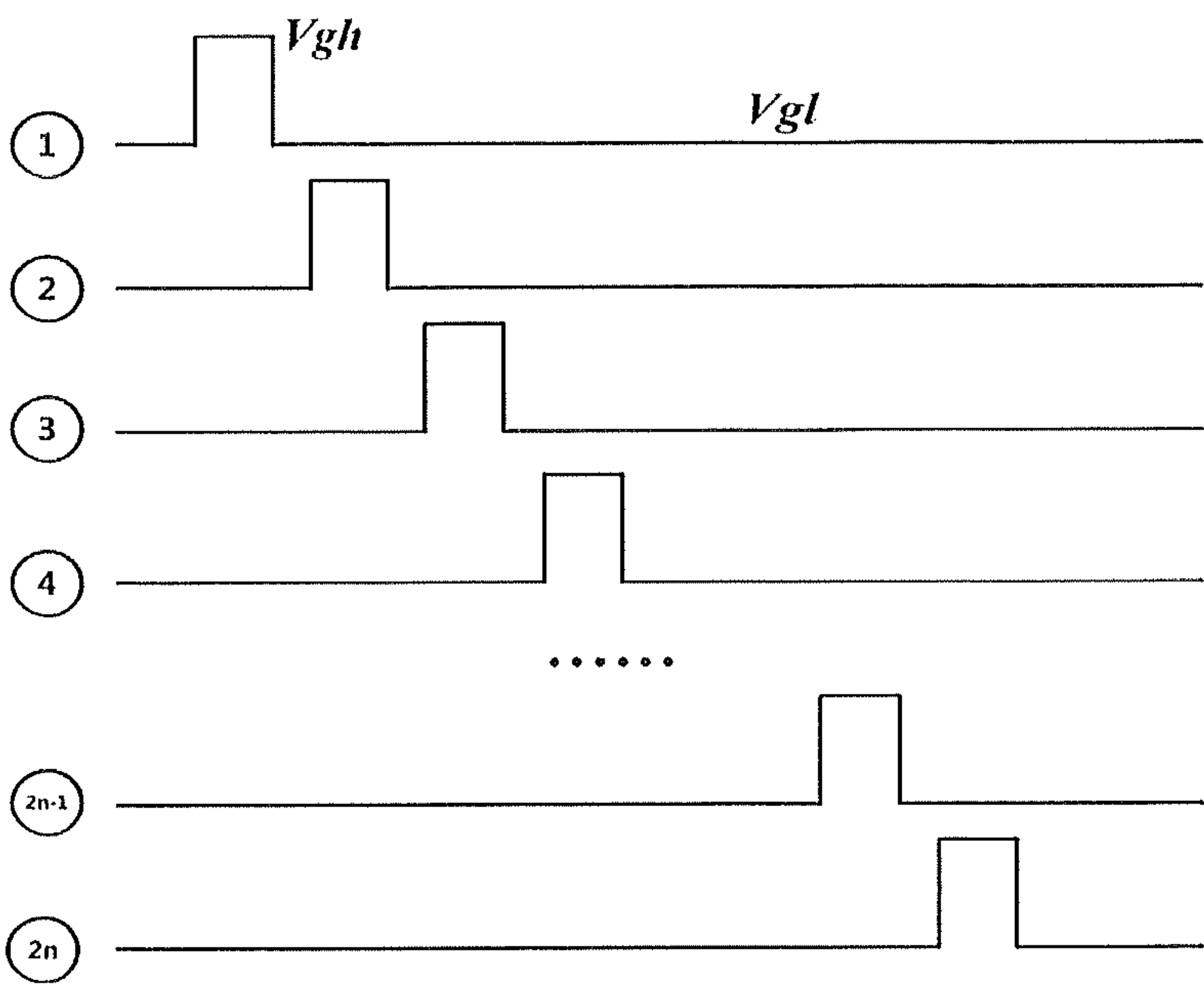


Fig. 3

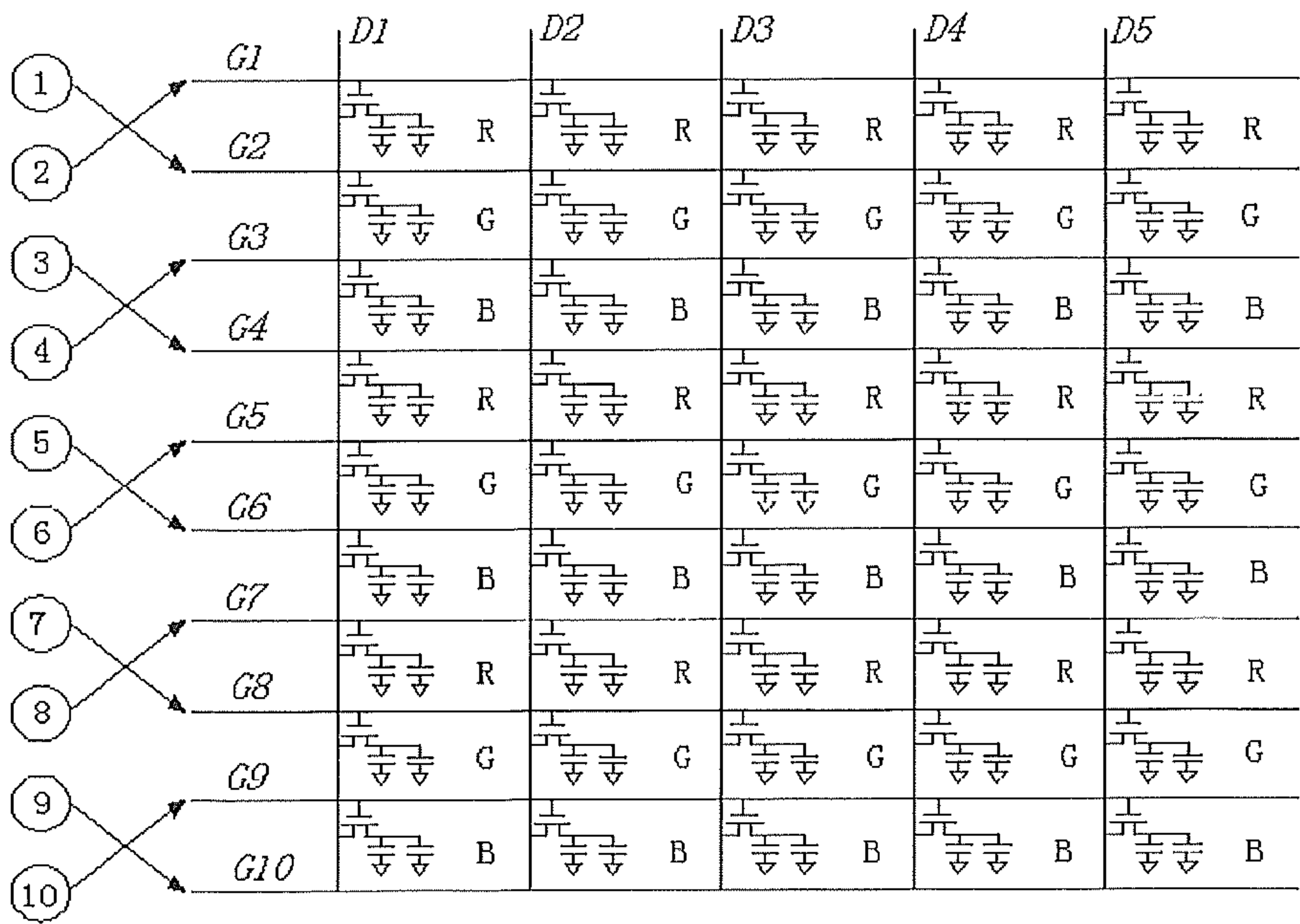


Fig. 4

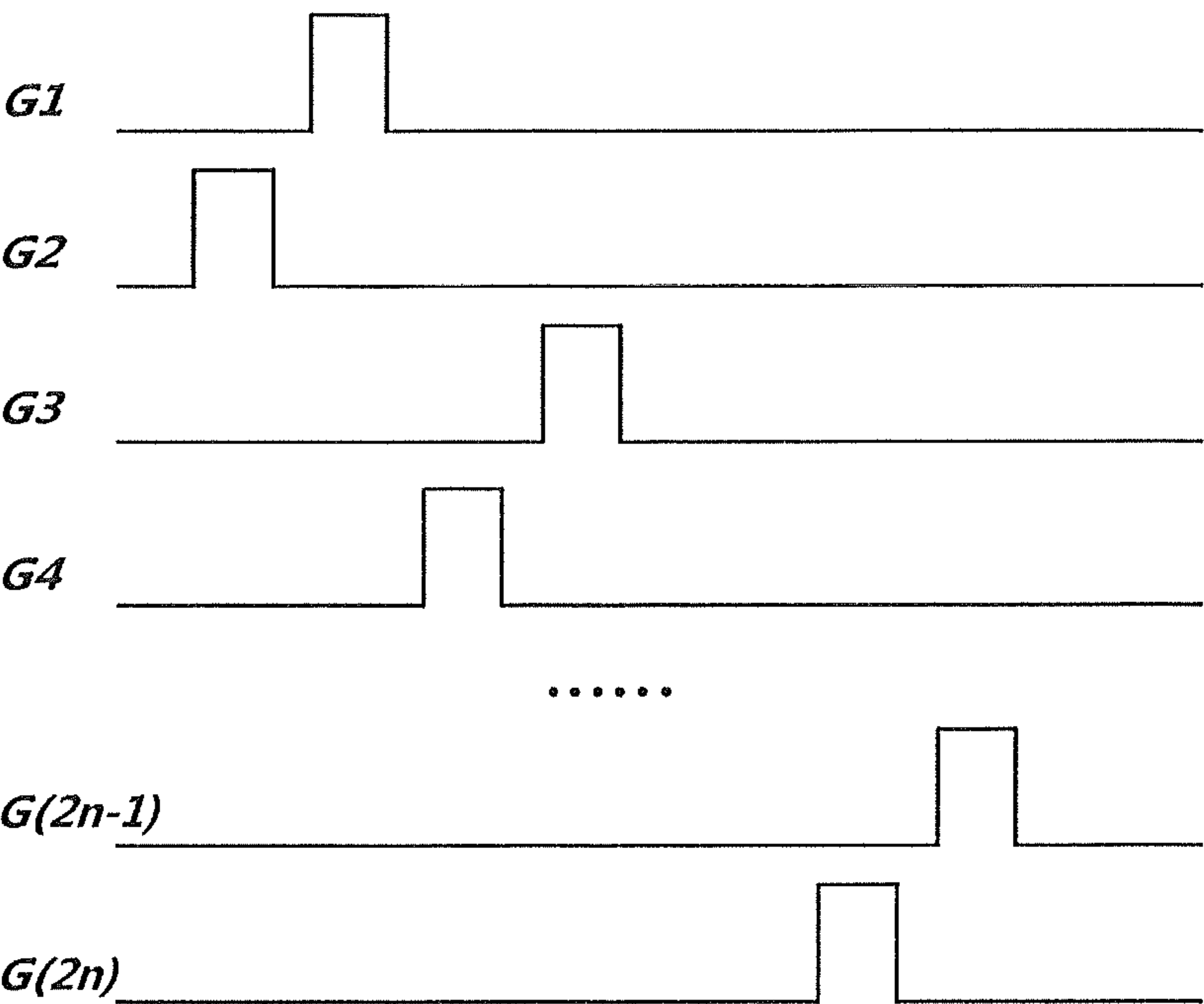


Fig. 5

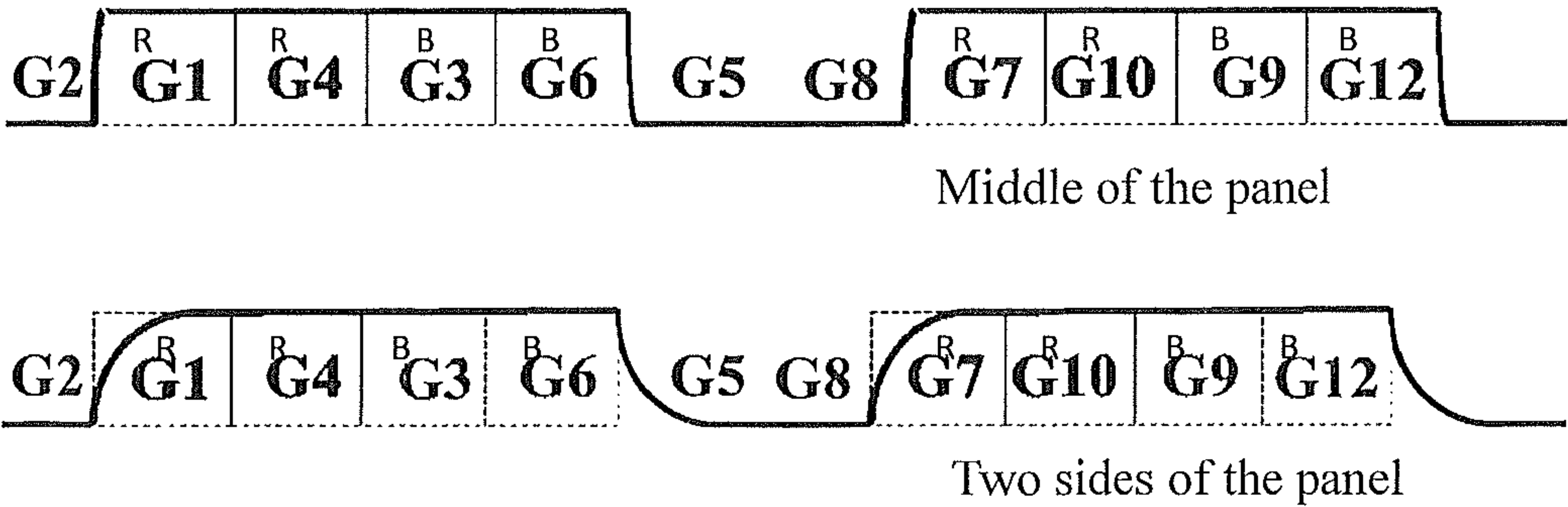


Fig. 6

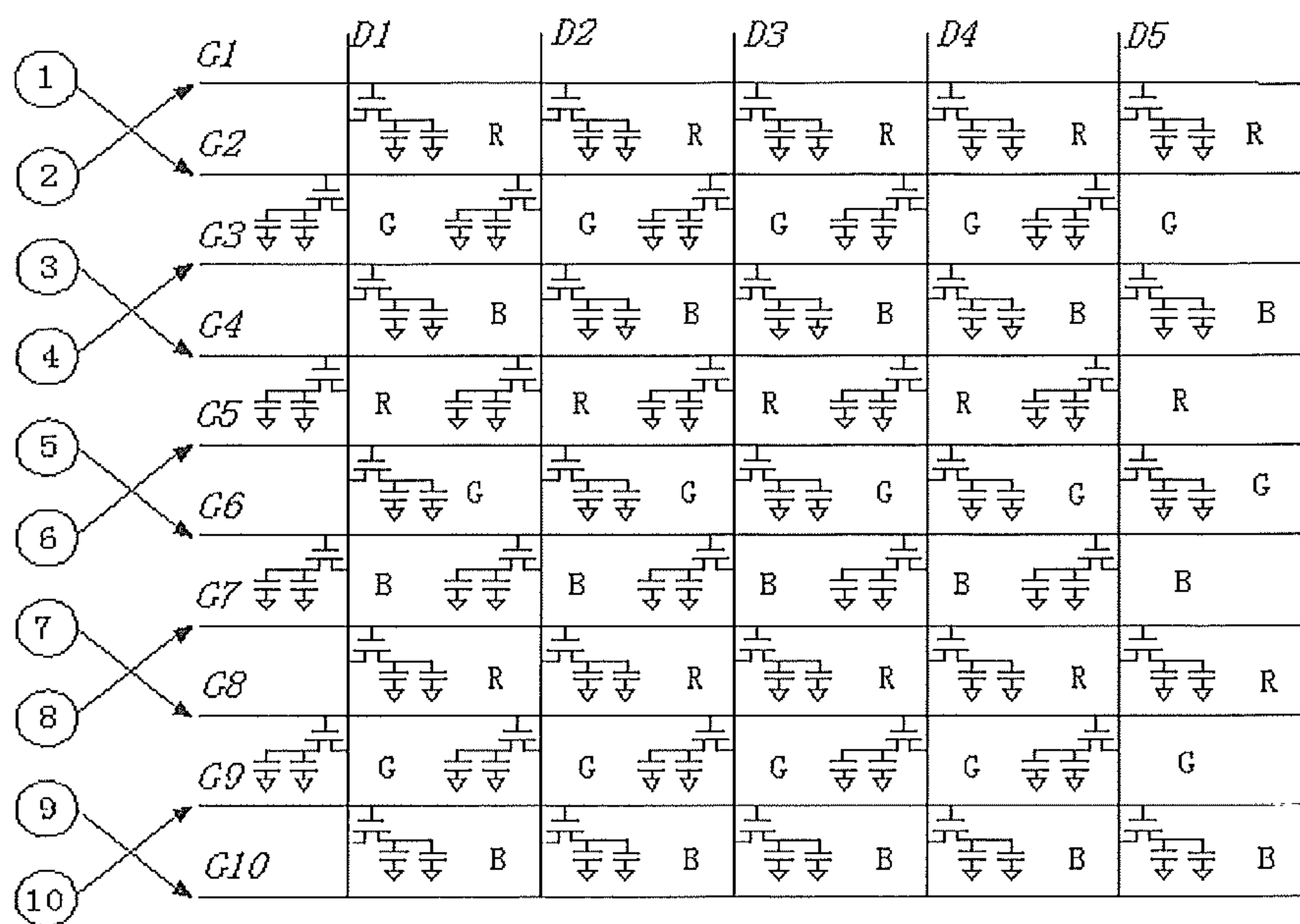


Fig. 7

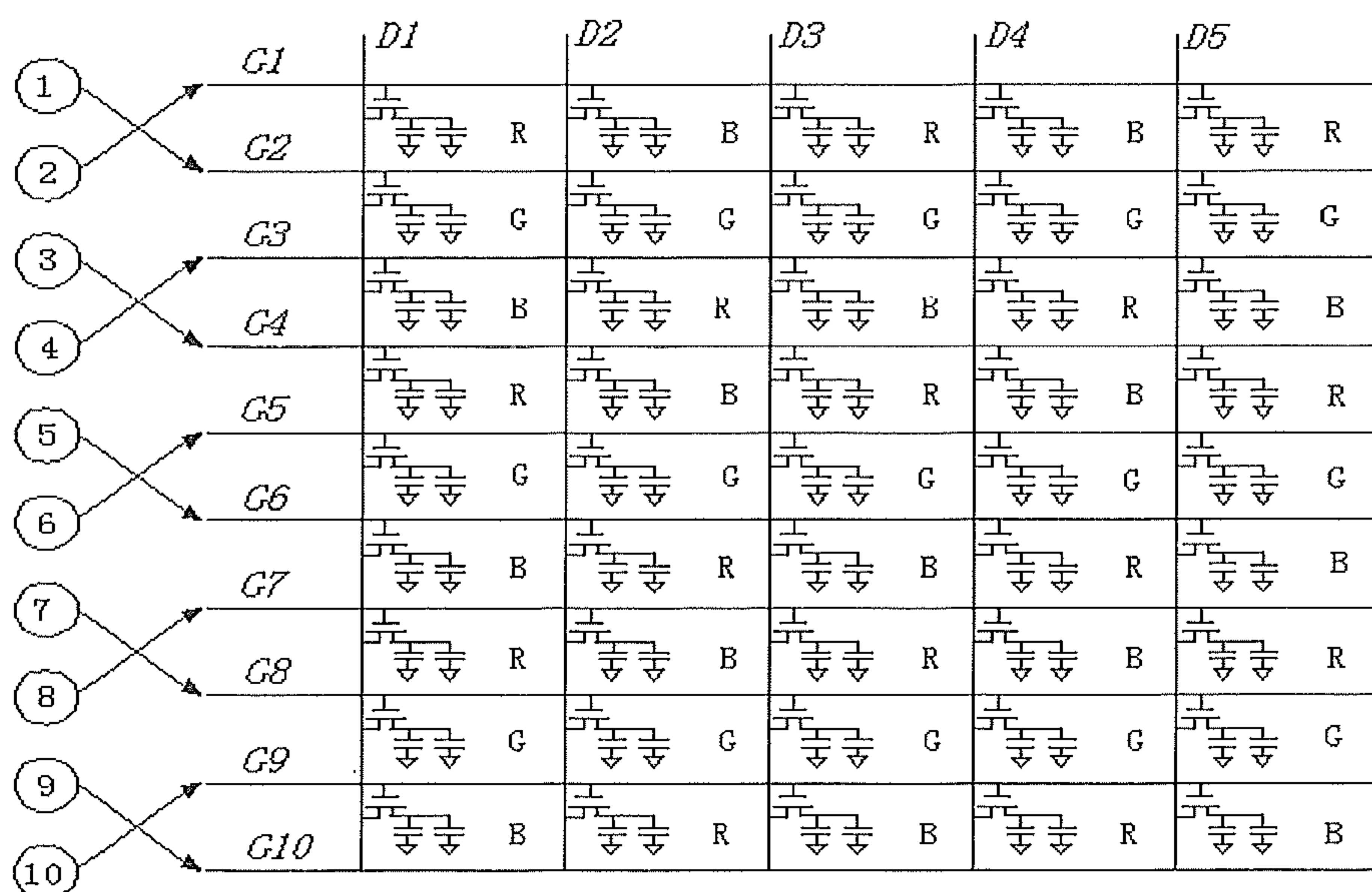


Fig. 8

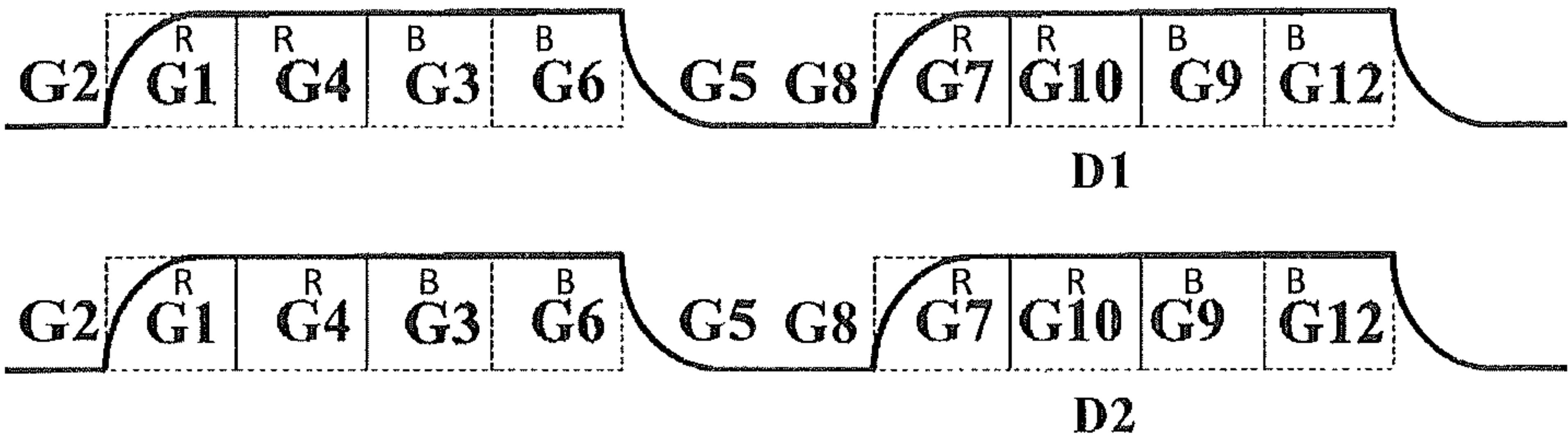


Fig. 9

1

TRI-GATE DISPLAY PANEL

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims benefit of Chinese patent application CN 201410559614.3, entitled "Tri-gate display panel" and filed on Oct. 20, 2014, the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present disclosure relates to the technical field of displays, and in particular to a tri-gate display panel.

BACKGROUND OF THE INVENTION

In designing a conventional tri-gate panel, the design of a high pin count is commonly adopted at a source side in order to save costs. For example, only one set of fanout terminals and one integrated circuit (IC) chip can be used at the source side. However, a fanout area thus designed generally has a large resistance difference ($R_{max}-R_{min}$) therein.

In practice, the major problem caused by a large impedance difference in the fanout area at the source side is color shifting at two sides of the panel during display of a blending picture. With respect to display of a blending picture, a data line would continuously charge two sub-pixels of a pixel before charging two sub-pixels of a next pixel. Since large impedance in the fanout area would cause rather severe RC delay of a signal, the charging condition of a first sub-pixel would be worse than that of a second sub-pixel. Especially for the fanout area having the largest wiring impedance, i.e., two sides of the panel, charging differences between sub-pixels would lead to color shifting.

As a result, a tri-gate display panel needs to be designed, in which, color shifting can be eliminated or would not be generated in displaying a blending picture.

SUMMARY OF THE INVENTION

In order to solve the above technical problems, the present disclosure provides a tri-gate display panel, in which, the color shifting phenomenon can be eliminated or would not be generated in displaying a blending picture. The panel comprises: a plurality of pixel units each including three sub-pixel units for displaying different colors, wherein each sub-pixel unit is provided with a thin film transistor, with its source connected to a charge electrode of the sub-pixel unit via a capacitor of the sub-pixel unit; a plurality of gate lines G1, G2, . . . , G(2n-1), G2n, which are successively arranged along a first direction of the display panel, so as to connect to gates of the thin film transistors of corresponding sub-pixel units; a plurality of data lines, which are successively arranged along a second direction of the display panel, so as to connect to drains of the thin film transistors of corresponding sub-pixel units; and a fanout area including a plurality of fanout lines, wherein output terminals of the plurality of fanout lines are arranged in accordance with the plurality of gate lines and are in pair-wise cross connections to the plurality of gate lines, such that when a high level pulse is applied to the fanout lines successively, the gate lines will be enabled in a sequence of G2, G1, . . . , G2n, G(2n-1).

According to one embodiment of the present disclosure, the three sub-pixel units are used for displaying the colors red, yellow, and blue, respectively.

2

According to one embodiment of the present disclosure, the sub-pixel units in two adjacent columns of pixel units are arranged in the same order of colors.

According to one embodiment of the present disclosure, each of the plurality of data lines is connected to drains of the thin film transistors of corresponding sub-pixel units located at one side of the data line.

According to one embodiment of the present disclosure, each of the plurality of data lines is connected to drains of the thin film transistors of corresponding sub-pixel units for displaying different colors located at both sides of the data line.

According to one embodiment of the present disclosure, the sub-pixel units in two adjacent columns of pixel units are arranged in opposite orders of colors.

According to one embodiment of the present disclosure, the data lines each charge four sub-pixel units simultaneously under the control of pulses of four corresponding gate lines.

In the present disclosure, the wiring mode on the panel has been changed, and the data lines, during operation, each charge four sub-pixels simultaneously. Thus, only half of the sub-pixel units are differently charged, thereby reducing charging differences between sub-pixels representing different colors. As a result, color shifting in a blending picture can be relieved, thus improving display quality of tri-gate display panels. When the sub-pixel units in two adjacent columns of pixel units are arranged in opposite orders of colors, charging differences between sub-pixel units representing different colors can be further attenuated under the same pulse sequence, thereby reducing overall color shifting.

In addition, with the wiring design of the present disclosure, the source fanout area can be designed with less restricted impedance, which renders it possible to compress the height of the fanout terminal in a larger extent, thereby facilitating design of panels with narrow frames.

Other features and advantages of the present disclosure will be further explained in the following description, and partly become self-evident therefrom, or be understood through implementing the present disclosure. The objectives and advantages of the present disclosure will be achieved through the structure specifically pointed out in the description, claims, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are provided for further understanding of the present disclosure, and constitute one part of the description. They serve to explain the present disclosure in conjunction with the embodiments, rather than to limit the present disclosure in any manner. In the drawings:

FIG. 1 shows a wiring diagram of fanout terminals and pixel units of a conventional tri-gate display panel;

FIG. 2 shows charging conditions of pixels located in a middle area and two side areas of a conventional tri-gate display panel in displaying the color purple;

FIG. 3 shows a timing sequence diagram of scan pulses provided to fanout terminals of a tri-gate display panel;

FIG. 4 schematically shows cross connections between fanout terminals and gate lines of pixels according to one embodiment of the present disclosure;

FIG. 5 shows a timing sequence diagram of pulses that occur on gate lines of the circuit as arranged in accordance with FIG. 4;

FIG. 6 shows a timing sequence diagram of charging four pixel electrodes at a time for displaying such as the color purple according to an embodiment of the present disclosure;

FIG. 7 shows a layout structure of a tri-gate panel according to a second embodiment of the present disclosure;

3

FIG. 8 shows a layout structure of a tri-gate panel according to a third embodiment of the present disclosure; and

FIG. 9 shows charging conditions of data lines D1 and D2 respectively according to the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present disclosure will be explained in details with reference to the embodiments and the accompanying drawings, whereby it can be fully understood how to solve the technical problem by the technical means according to the present disclosure and achieve the technical effects thereof, and thus the technical solution according to the present disclosure can be implemented. It is important to note that as long as there is no conflict, all the technical features mentioned in all the embodiments may be combined together in any manner, and the technical solutions obtained in this manner all fall within the scope of the present disclosure.

FIG. 1 shows a wiring diagram of fanout terminals and pixel units of a conventional tri-gate display panel which adopts the design of a high pin count at a source side. In the figure, D1 to D5 represent data lines, while G1 to G10 represent gate lines. The circled numbers indicate serial numbers of fanout lines.

FIG. 2 shows charging conditions of pixels in displaying a blending picture of red and blue on the tri-gate display panel corresponding to FIG. 1. Gate lines (or scan lines) are successively enabled from the top down. Due to a significant difference of impedances between a middle area of the display panel and source fanout terminals at two sides of the display panel, the conditions of RC delay of signals for the data lines are also different from each other. The phenomenon of RC delay of signals for data lines at two sides of the display panel would be severer, as shown in the waveforms of FIG. 2. During operation of red and blue sub-pixels, the data lines charge the blue sub-pixels first and then the red sub-pixels. Due to significant delay of signal waveforms at two sides of the panel, compared with a place in the middle of the panel, the blue sub-pixels at two sides of the panel are all more poorly charged than the red sub-pixels. As a result, a purple picture displayed would finally be reddish at two sides of the panel, while an opposite scan direction would render the purple picture bluish at two sides of the panel. Similar problems would arise in displaying blue or aqua blue pictures.

FIG. 3 shows a sequence diagram of scan pulses provided to fanout terminals of a tri-gate display panel. According to the conventional wiring mode as shown in FIG. 1, the fanout terminals each connect to a corresponding gate line. Hence, the timing sequence of the scan pulses with respect to the fanout terminals is consistent with that for the gate lines. In this figure, V_{gh} represents a high level voltage, and when the signal of a gate line indicates a high level voltage, TFTs connected thereto will be turned on, followed by charging of corresponding pixels; and V_{gl} represents a low level voltage, and when the signal of the gate line indicates a low level voltage, TFTs connected thereto will be turned off. From the circled numbers, it can be conceived that the wiring relations between the fanout area and the gate lines as shown in FIG. 1 would enable the gate lines in the panel successively in a sequence of 1, 2, 3, . . . , 2n-1, 2n. Consequently, inconsistent charging periods as shown in FIG. 2 would arise, which would further lead to the problem of color shifting.

In order to solve the above problems, the present disclosure provides a wiring mode for a display panel, as indicated in FIG. 4. FIG. 4 schematically shows cross connections

4

between fanout terminals and gate lines of pixels according to one embodiment of the present disclosure.

In the circuit as shown in FIG. 4, the display panel comprises a plurality of pixel units each including three sub-pixel units for displaying different colors, wherein each sub-pixel unit is provided with a thin film transistor, with its source connected to a charge electrode of the sub-pixel unit via a capacitor of the sub-pixel unit; a plurality of gate lines G1, G2, . . . , G(2n-1), G2n, which are successively arranged along a first direction, e.g., line direction or horizontal direction, of the display panel, so as to connect to gates of the thin film transistors of corresponding sub-pixel units; a plurality of data lines D1, D2, . . . , Dm, which are successively arranged along a second direction, e.g., column direction or vertical direction, of the display panel, so as to connect to drains of the thin film transistors of corresponding sub-pixel units; and a fanout area including a plurality of fanout lines, wherein output terminals of the plurality of fanout lines are arranged in accordance with the plurality of gate lines and are in pair-wise cross connections to the plurality of gate lines, such that when a high level pulse is applied to the fanout lines successively, the gate lines will be pulsed on in a sequence of G2, G1, . . . , G2n, G(2n-1).

In one embodiment of the present disclosure, the three sub-pixel units are used for displaying the colors red, yellow, and blue, respectively. Of course, the present disclosure is not limited hereto, and the sub-pixel units can be combinations of other colors also.

In one embodiment of the present disclosure, each data line is connected to drains of the thin film transistors of corresponding sub-pixel units located at one side of the data line. Under the control of pulses of corresponding gate lines, the data lines each charge four sub-pixel units simultaneously. The charging waveforms are shown in FIG. 6.

In the circuit of the panel layout as shown in FIG. 4, the sub-pixel units in two adjacent columns of pixel units are arranged in the same order of colors. Definitely, the sub-pixel units in two adjacent columns of pixel units can be arranged in opposite orders of colors also, as FIG. 8 shows. In FIG. 8, odd-numbered data lines each correspond to an RGB sequence (i.e., the sequence of red, green, and blue) of pixel colors, while even-numbered data lines each correspond to a BGR sequence (i.e., the sequence of blue, green, and red) of pixel colors. FIG. 9 shows charging conditions of data lines D1 and D2 as an example.

Under this wiring mode, the data lines each continuously charge four sub-pixel units at a time also. Reference will be made to display of a purple picture in a similar manner. When odd-numbered data lines are enabled for charging, first red sub-pixels would be poorly charged, while when even-numbered data lines are enabled for charging, first blue sub-pixels would be poorly charged. On the whole, charging differences between different colors of sub-pixels have disappeared, such that color shifting at two sides of the panel has been eliminated mostly as compared with the case under the conventional wiring mode.

In a conventional design as presented in FIG. 1, the wiring numbers in the fanout area and the numbers of gate lines in the panel are completely correspondent, in which a fanout line is connected to a same-numbered gate line. Hence, the fanout lines and the gate lines are both enabled in a sequence of 1, 2, 3, . . . , 2n-1, 2n. However, in the structure indicated in FIG. 4, such connection manner has been altered, so that wiring line 2n-1 in the fanout area is connected to gate line 2n in the panel, while wiring line 2n in the fanout area is connected to gate line 2n-1 in the panel. Wiring numbers in the fanout area are consistent with the conventional design as described

5

above. However, due to variation of the connection manner, the gate lines in the panel will be enabled in different orders, with corresponding waveforms shown in FIG. 5.

In timing sequence, the gate lines within the panel are enabled in an order of 2, 1, 4, 3, . . . , 2n, 2n-1.

The colors of sub-pixels and waveforms of data lines corresponding to gate lines in FIG. 5 are each shown in FIG. 6. Under this wiring mode, data lines D1 to D5 each charge four sub-pixels at a time, thereby attenuating charging differences between different colors of sub-pixels. Similarly, reference will be made to display of a purple picture, whereby the gate lines are enabled successively from the top down. In this case, the waveforms of the data line signals in the middle and at two sides of the panel are shown in FIG. 6, with the data lines each charging four sub-pixels at a time. Due to severe RC delay at two sides of the panel, the first of the four sub-pixels will be poorly charged compared with the other three sub-pixels. However, on the whole, charging differences between the red and blue sub-pixels only occur to half of the sub-pixels at two sides of the panel, while the other half of the red and blue sub-pixels are equally charged. In a conventional tri-gate display panel design, however, all red sub-pixels at two sides of the panel will be differently charged from blue sub-pixels. Therefore, the wiring mode according to the present disclosure can effectively eliminate charging differences between different colors of sub-pixels, thereby significantly relieving color shifting at two sides of the panel.

FIG. 7 shows a second embodiment of the present disclosure, in which each of the data lines is connected to drains of thin film transistors of different colors of sub-pixel units located at two sides of the data line, such that the sub-pixels located at two sides of the data line are alternately charged by the data line, thereby relieving color shifting at two sides of the panel. Compared with the wiring mode as shown in FIG. 4, the wiring mode shown in FIG. 7 can produce the same effects of relieved color shifting. However, with the wiring mode shown in FIG. 7, power consumption of single data lines can be reduced by charging a pixel unit with two data lines alternately, thereby prolonging service life of a display panel.

With the new wiring mode of a display panel, charging differences between different colors of sub-pixels can be reduced, thereby eliminating color shifting at two sides of a blending picture and improving display effects. In addition, the source fanout area can be designed with less restricted impedance, which facilitates achievement of design of narrow frames.

The above embodiments are described only for better understanding, rather than restricting, the present disclosure. Any person skilled in the art can make amendments to the

6

implementing forms or details without departing from the spirit and scope of the present disclosure. The scope of the present disclosure should still be subject to the scope defined in the claims.

The invention claimed is:

1. A tri-gate display panel, comprising:

a plurality of pixel units, each including three sub-pixel units for displaying different colors, wherein each sub-pixel unit is provided with a thin film transistor, with its source directly connected to a charge electrode of a corresponding sub-pixel unit via a capacitor of the sub-pixel unit;

a plurality of gate lines G1, G2, . . . , G(2n-1), G2n, which are successively arranged along a first direction of the display panel, so as to connect to gates of the thin film transistors of corresponding sub-pixel units;

a plurality of data lines, which are successively arranged along a second direction of the display panel, so as to directly connect to drains of the thin film transistors of corresponding sub-pixel units; and

a fanout area including a plurality of fanout lines which are successively arranged along the first direction of the display panel, wherein output terminals of the plurality of fanout lines are arranged in accordance with the plurality of gate lines and are in pair-wise cross connections to the plurality of gate lines, such that when a high level pulse is applied to the fanout lines successively, the gate lines will be enabled in a sequence of G2, G1, G2n, G(2n-1).

2. The tri-gate display panel according to claim 1, wherein the three sub-pixel units are used for displaying the colors red, yellow, and blue, respectively.

3. The tri-gate display panel according to claim 2, wherein the sub-pixel units in two adjacent columns of pixel units are arranged in the same order of colors.

4. The tri-gate display panel according to claim 3, wherein each of the plurality of data lines is connected to drains of the thin film transistors of corresponding sub-pixel units for displaying different colors located at both sides of the data line.

5. The tri-gate display panel according to claim 2, wherein each of the plurality of data lines is connected to drains of the thin film transistors of corresponding sub-pixel units located at one side of the data line.

6. The tri-gate display panel according to claim 5, wherein the sub-pixel units in two adjacent columns of pixel units are arranged in opposite orders of colors.

7. The tri-gate display panel according to claim 1, wherein the data lines each charge four sub-pixel units simultaneously under the control of pulses of four corresponding gate lines.

* * * * *